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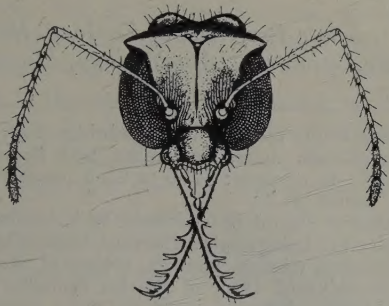

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PSYCHE

Vol. 67 March-June, 1960 Nos. 1-2

THE GENUS *PSEUDOSINELLA* (COLLEMBOLA, ENTOMOBRYIDAE) IN CAVES OF THE UNITED STATES[1]

By K. Christiansen

Grinnell College, Grinnell, Iowa

In 1934 Bonet listed two troglophile species of the genus *Pseudosinella, P. decipiens* and *P. sexoculata,* from caves of the United States. In 1949 Delamare described two new troglobite species, *P. hirsuta* and *P. spinosa,* and placed them in a new genus *Troglosinella.* The present work is the result of the examination of more extensive collections from caves in the United States and has resulted in the addition of four more troglophile forms and the discovery of five new troglobite species. The work covered in this paper was made possible by a National Science Foundation Grant, No. G4563. Mr. Jerry Tecklin did much of the manual labor involved in preparation and he, Mr. James Hedges and Mr. George Darland, made a collecting trip through Missouri and northern Arkansas, recovering a good deal of critical material. Most of the remaining specimens were collected by Mr. and Mrs. Thomas Barr or Mr. Carl Krekeler. I wish to thank all of these people.

Distribution

Collections are relatively complete only from the region immediately around Tennessee and Kentucky; however, we have a sufficient scattering of material from other regions to be able to discern the probable outline of the distribution of the group. The species of this genus are more widespread in caves than those of the genus *Sinella* previously reported, but the troglobite forms are still largely limited to the southeast quadrant of the country. In the troglophile forms the extensive invasion of the caves of Missouri and Arkansas is the most notable phenomenon. Generally speaking, the troglobite forms are severely restricted in distribution and, in cases of numerous collections, more or less continuous. The troglophile forms are much more wide-

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[1] Published with the aid of a grant from the Museum of Comparative Zoology at Harvard College.

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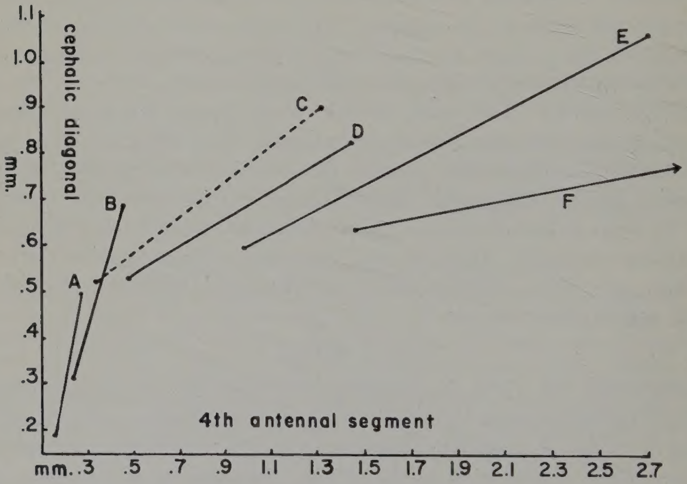
spread and occur in widely disjunct populations. As was true in *Sinella,* the majority of the collections of troglophile forms falls outside of the areas occupied by the troglobite species.

Biology

Little accurate, detailed information is available concerning the biology of the members of this genus. The visible gut contents indicate that fungal hyphae and spores make up the major portion of the diet of most members. The incompleteness of the data on and collections of both cave and epigeic forms of this genus makes it difficult to classify the habitat of the various species. On a basis of present data we can place the forms described here into four groups: 1) the definite troglobites — including *P. spinosa, P. boneti, P. espana, P. hirsuta,* and *P. gisini;* 2) the doubtful troglobites — *P. dubia* and *P. orba;* 3) the doubtful troglophile — *P. argentea*; and 4) the definite troglophiles — *P. petterseni, P. alba, P. folsomi, P. duodecimpunctata,* and *P. sexoculata.*

GRAPH I



Graph 1. Curves showing the differing ratios of the fourth antennal segment to the cephalic diagonal in the cave species of U. S. *Pseudosinella.* A includes: *P. argentea, P. folsomi, P. duodecimpunctata, P. alba,* and *P. sexoculata*; B: *P. dubia;* C (a probable average of several curves): *P. hirsuta*; D: *P. gisini*; E: *P. spinosa*; and F: *P. boneti.*

Systematic Account: General Discussion

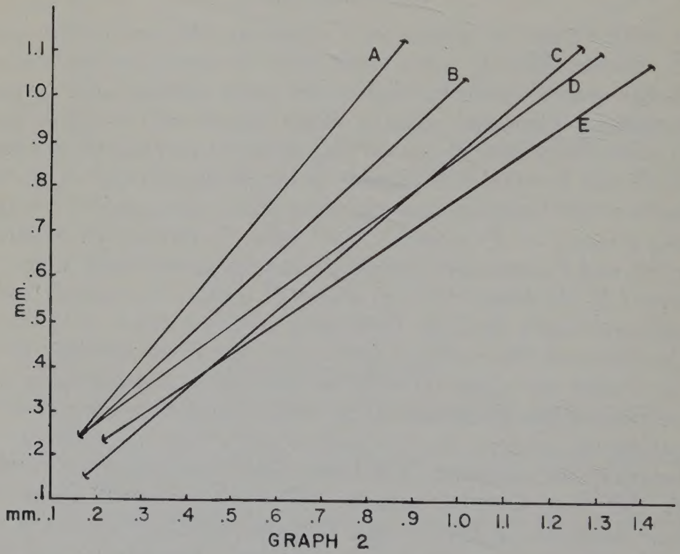
The genus *Troglosinella* was created by Delamare for the species *hirsuta* and *spinosa*. Examination of much more extensive material encompassing several new species makes it clear that the generic limits set up by Delamare are impractical. Two of the most basic characteristics used to separate the genus (the ringing of the fourth antennal segment, and the small non-lamellate teeth) are present in some forms of *hirsuta* and absent in others. Beyond this the reduced tooth structure of the unguis appears in a number of separate epigeic forms. The spines of the dens, also used to separate the genus, are found in only one species (*P. spinosa*) and the "heavy hairs" found on the dorsum of the dens in *hirsuta* are found in large specimens throughout the whole of *Pseudosinella.* In view of this, and my failure to discover any other practical way to separate the genus from *Pseudosinella,* I consider *Troglosinella* Delamare to be a synonym of *Pseudosinella* Schäffer. It is regrettable that this is unavoidable, since the species clustered around *P. spinosa* do represent an evolutionary unit.

Ratios and Size

As with almost all groups of Collembola, the size of the species varies considerably. It is extremely risky to determine the size of a particular species upon anything except large samples from a variety of localities. Time and again a whole sample will be made up of small individuals, or will consist exclusively of extra-large specimens. With all this in mind it is possible to break the cave species of *Pseudosinella* of the United States into three size ranges: small (averaging around 1 mm.) — *P. espana* (?), *P. alba, P. folsomi, P. duodecimpunctata,* and *P. sexoculata*; medium (averaging between 2-3 mm.) — *P. orba* (?), *P. boneti* (?), *P. dubia, P. gisini, P. argentea* and *P. hirsuta*; and finally the large (averaging around 4 mm.) — *P. spinosa.*

The ratios of the various organs vary, but if we consider all the species, almost any organ ratio can be expressed as a straight line, with one or two notable exceptions. The only striking exceptions involving several species concern the first and second abdominal segments and the length of the antennae. The latter is illustrated in graph 1, which shows the most sensitive segment, the fourth, plotted against the cephalic diagonal. It can be seen that the most highly evolved cave forms develop progressively longer antennae. For most of the other organs a single straight line can express the growth changes and encompass all species. Graph 2 shows a summary of such growth lines for organs of the various parts of the body. There are a few variations from the norm in several of these curves. The most striking is in connection with one population of *P. hirsuta* which has a longer fourth abdominal segment than is normal, and in all of the specimens examined of *P. duodecimpunctata* which have the manubrium, longer than is normal in the remaining species. It is quite probable that more exhaustive analysis will point out more such exceptions; however, it is apparent that there is little difference among the various species in most organ ratios.

The genus *Pseudosinella* under any definition is a patently polyphyletic group with characteristics largely determined by a particular ecology; it can be distinguished from its ancestral genus *Lepidocyrtus* upon only one basis — the reduction in the number of eyes. *Pseudosinella* usually shows additional characteristics in the loss of pigment and the modification of the unguis structure, either through great elongation and reduction in the size and number of inner teeth and/or through the enlargement of the basal inner ungual teeth. Within the North American cave forms there are three and possibly four separate evolutionary lines involved. Only one of these, the group including



Graph 2. Curves for five different organ ratios, each curve being a composite of all species. In the key below the ordinate is given first in each case. A: cephalic diagonal/second theoracic segment; B: cephalic diagonal/third tibiotarsus; C: manubrium/mucrodens; D: cephalic diagonal/mucrodens; E: cephalic diagonal/fourth abdominal segment.

P. spinosa, has gone through extensive evolution within the caves. In spite of the diverse origins of the species of this genus the forms are normally quite similar. The thorax has a somewhat enlarged second segment and the mucro is bidentate with a basal spine. The chaetotaxy is very uniform with macrochaetae on the head being commonly numerous only along the antennal bases, between the antennae, and on the anterior half of the ventral surface. The mesothorax has a series of rows along the anterior margin, and the lateral surface of the fourth segment and the last two segments have sparse coverings. Scattered macrochaetae and groupings of from two to four odd, short, feathered setae and one long filamentous ciliate seta occur on the third and fourth abdominal segments (See figure 11). The scales are hyaline, finely striate and apically rounded. On the whole we have an artificial but readily separated genus.

Key to the Cave Species of *Pseudosinella* of the United States

1) Empodial appendage with a clear wing-like tooth at the end of a separate outer lamella 2
1′) Empodial appendage with a small outer tooth or toothless 4
2) Mucro without basal spine .... *P. espana* n. sp.
2′) Mucro with basal spine 3
3) Unguis with median unpaired inner tooth .... *P. petterseni*
3′) Unguis without median unpaired innner tooth .... *P. folsomi*
4) Dens with spines .... *P. spinosa*
4′) Dens without spines 5
5) With eyes 6
5′) Eyeless 11
6) Two or fewer eyes per side 7
6′) Three or more eyes per side[2] 9
7) All inner ungual teeth small 8
7′) Basal, and sometimes all inner teeth large, two eyes per side .... *P. alba*
8) Tenent hair weakly clavate and/or median unpaired inner ungual tooth absent .... *P. gisini* n. sp.
8′) Tenent hair acuminate, median unpaired inner ungual tooth present .... eyed forms of *P. hirsuta*
9) Three eyes per side on two separate eyepatches .... *P. sexoculata*
9′) Some members of each population with more than three eyes per side, always on one eyepatch 10
10) All inner ungual teeth subequal, typically five eyes per side .... *P. dubia* n. sp.

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[2] Occasional members of a population with four or more eyes may be eyeless.

10′) Basal inner ungual teeth clearly larger than others, typically six eyes per side .... *P. duodecimpunctata*

11) Fourth antennal segment more than two times as long as cephalic diagonal .... *P. boneti* n. sp.

11′) Fourth antennal segment less than one and seven-tenths times as long as cephalic diagonal 12

12) Distance from distal base of largest inner ungual tooth to base of unpaired inner tooth less than half that from unpaired tooth to apex of unguis (See figure 44), macrochaetae present in median field of dorsum of head .... *P. orba* n. sp.

12′) Distance from largest basal inner tooth to median unpaired tooth at least half as great as distance from apical tooth to apex of unguis, macrochaetae absent from median field of dorsum of head 13

13) One or both basal inner ungual teeth large and prominent (See figure 31), ratio of fourth antennal segment to cephalic diagonal less than .8 .... *P. argentea*

13′) Both basal inner ungual teeth small (See figure 47), and/or ratio of fourth antennal segment to cephalic diagonal greater than .8 .... eyeless forms of *P. hirsuta*

EXPLANATION OF PLATE 1

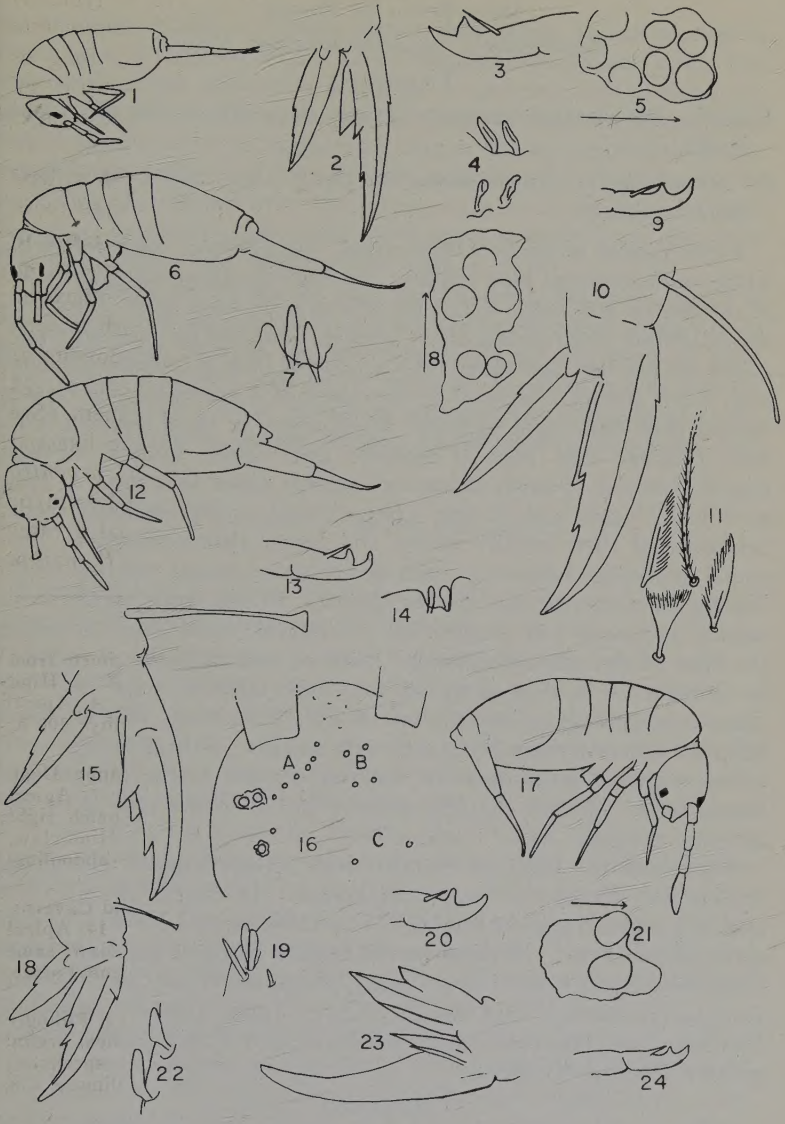
Figures 1-5: *Pseudosinella duodecimpunctata*. 1. Habitus, specimen from New River Cave, Giles Co., Va.; setae and pigment omitted; 19 X. 2. Hind claw. same specimen; 900 X. 3. Mucro, same locality; 900 X. 4. Apical organs, third antennal segments two different specimens, same locality; 900 X. 5. Eyes and eye patch, same locality; 900 X.

Figures 6-11: *P. dubia* n. sp. 6. Habitus, specimen from Granny Dean Cave, Washington Co., Ark.; setae and pigment omitted; 18 X. 7. Apical organ, third antennal segment, same specimen; 900 X. 8. Eye patch right side, same specimen; 250 X. 9. Mucro, same specimen; 500 X. 10. Hind claw, same specimen; 500 X. 11. Typical setae association of fourth abdominal segment, paratype; 900 X.

Figures 12-16: *P. sexoculata*. 12. Habitus, specimen from Carlsbad Caverns, N. Mex., setae omitted, 30 X. 13. Mucro, same specimen, 900 X. 14. Apical organ third antennal segment, same specimen; 900 X. 15. Hind claw, same specimen; 900 X. 16. closeup of head, same specimen, A.-interantennal setae, B.-antennal base setae, C.-median field setae; 150 X.

Figures 17-21: *P. alba*. 17. Habitus, specimen from Niagra Cave, Fillmore Co., Minn.; 30 X. 18. Hind claw, same specimen; 900 X. 19. Apical organ, third antennal segment, same specimen; 900 X. 20. Mucro, same specimen; 900 X. 21. Right eye patch, specimen from Mystery Cave, Fillmore Co., Minn.; 300 X.

Figures 22-24: *P. folsomi*. 22. Apical organ. third antennal segment, specimen from Limberlost Valley Cave, Newton Co., Mo.; 900 X. 23. Hind claw, same specimen; 900 X. 24. Mucro, epigeic specimen from Harahan, La.; 500 X.



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Descriptions of Species

Pseudosinella duodecimpunctata Denis

Figures 1-5

Pseudosinella duodecimpunctata Dennis 1931, Mem. Soc. Ent. Ital. *10*:82.

P. (Pseudosinella) duodecimoculata Bonet 1931, Mem. Soc. Esph. N.H. *14*:324-6.

Facies typical of genus *Lepidocyrtus*. Background color yellowish white, with scattered blue pigment, particularly heavy along the sides of the thorax and head. Head broadly oval in shape with a clear V-shaped dorsal area marked off by pigment; six eyes per side on trapezoidal eye patches. Antennae 1.2-1.4 times as long as cephalic diagonal with third antennal segment in the form of a truncate cone clearly shorter than the second segment; apical organ of third segment with two irregular oval pegs in separate deep folds. Second thoracic slightly humped. Fourth abdominal segment about four times as long as third. Unguis with a clear external tooth and three inner teeth; basalmost of these usually salient and larger than remainder. Empodial appendage lanceolate, with one or more minute external teeth. Tenent hair curved and clearly clavate. Mucro with apical tooth weakly upturned and longer than anteapical, basal spine attaining the apex of the anteapical tooth. Anterior macrochaetae as follows: on dorsum of head a group of four interantennal setae near the anterior margin and a curved row of seven setae along each antennal base, the anterior three being distinctly smaller; ventral surface with a few scattered setae near the anterior margin of the median and lateral areas. Second thoracic segment has a double row along the anterior margin.

Type locality: Buco de Piombo, Italy. Distribution: widespread in southern Europe in caves and epigeic. In North America the species has been taken in Florida, Massachusetts, and North Carolina as an epigeic form. In caves of the United States it has been taken from New River Cave, Giles County, Virginia; Wind Cave, Jackson County, Kentucky; Old Spanish Cave, Stone County, Missouri; Panther Cave, Newton County Missouri; and Foster's Cave, Montgomery County, Tennessee.

Discussion

The most striking variations seen in this troglophile species are in the number of eyes and amount of pigment. Most specimens have the twelve eyes characteristic of the species; but forms with ten eyes are common; rarely, specimens appear with fewer, as can be seen in those from Tennessee which have from none to six per side. The tibiotarsus of this population is slightly longer than is normal for the species, but they are otherwise similar to forms seen elsewhere. This would appear to be an example of cave evolution proceeding within a population and would be worth additional study. Pigment may be uniformly distributed over the whole body or limited to the head region. The apical organ of the third segment varies from the condition described to two subcylindrical pegs.

The identity of this species with the European specimens is still in doubt as no comparisons could be made; however, there appears to be good agreement between the descriptions and the specimens at hand. This species may very well be the same as *P. collina,* which was described by Wray (1952) as having only two internal ungual teeth; but until this can be checked the two species must be considered separate.

Pseudosinella dubia, new species

Figures 6-11

Facies typical of genus. Background color white with an overall scattering of blue pigment, particularly dark on dorsum of head where it forms a diamond shaped mark between the eye patches. Head broadly oval; eyepatches elongate trapezoids, each bearing five eyes in two groups, an anterior group of three and a posterior group of two. Antennae about one and one half times as long as the cephalic diagonal; first three segments subcylindrical and fourth segment fusiform. Fourth segment dorsally with numerous blunted smooth setae of several different sizes and shapes; apical organ of third segment with two irregular flattened elliptical rods in a fold, and about fifteen additional blunt curved setae scattered over the inner ventral surface of the segment. Second thoracic segment markedly humped forcing the head into a slightly hypognathous position. Fourth abdominal segment about five times as long as third. Unguis with minute basal external tooth and three small internal teeth, with basal-most inner tooth on a level and frequently appearing as one under low magnification. Empodial appendage lanceolate, with a small but clear external teeth, exceeding the level of the unpaired internal ungual tooth. Tenent hair weakly clavate. Mucro with apical tooth about twice as long as subapical, and markedly upturned; basal spine exceeding the apex of subapical tooth. Anterior macrochaetae as follows: on dorsum of head four interantennal setae, the posterior pair closer together, and a curved row of eleven setae around each antenna base; ventral surface with a few scattered setae on the anterior median portion.

Type locality: Devils Den Kitchen Cave, Washington County, Arkansas, IX-9-'59, Tecklin, Hedges and Darland coll. Also taken from Granny Dean and Devils Den Caves, Washington County. Arkansas.

Discussion

The number of eyes varies considerably, most specimens having five per side. However, many have four per side; in such cases it is the posteriormost eye of the anterior three which is missing, and the position of this eye is variable even when it is present. The tenent hair varies from acuminate to markedly clavate.

The taxonomic position, name and limits of this species are all moot. The species is clearly distinguished from the form called here *P. duodecimpunctata.* The antennae of *dubia* are longer, and the eye number typically different. The shape of the eye patch and distribution of the eyes are also different, as is the structure of both mucro and unguis. The question of the relationship between this form and Wray's *collina* or Guthrie's *Lepidocyrtus decemoculatus* is less easily settled. The present species appears to differ from *collina* in (1) the number of eyes (six vs. five per side typically); (2) the relative lengths of abdominal segments three and four (*collina* one: four, *dubia* one: five +); (3) antennal ratios; and (4) the comparison of lengths of the manubrium and dens. In addition, Wray's figures show the basal spine of the mucro not reaching the anteapical tooth and the unguis

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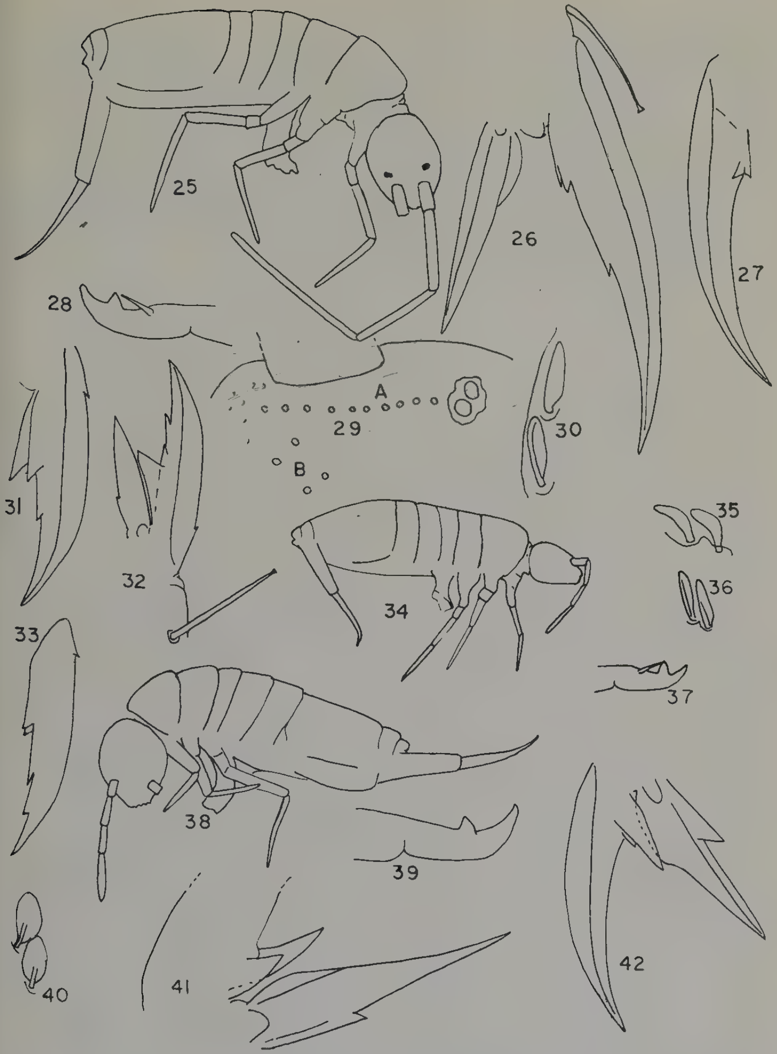
Explanation of Plate 2

Figures 25-30: *P. gisini* n. sp. 25. Habitus, specimen from Higgenbotham Cave, Greenbrier Co., W. Va., setae and pigment omitted; 12 X. 26. Hind claw, paratype; 350 X. 27. Hind unguis, specimen from McFerrin Cave, Greenbrier Co., W. Va.; 250 X. 28. Mucro, same specimen; 250 X. 29. Dorsal setae and eyes right side, paratype, Greenbrier Co., W. Va.; A.-interantennals, B.-antennal base setae; 120 X. 30. Apical organ, third antennal segment, specimen from McClung Cave, Greenbrier Co., W. Va.; 350 X.

Figures 31-37: *P. argentea.* 31. Typical hind unguis, specimen from Eli Reed Cave, Larue Co., Ky.; 350 X. 32. Hind claw showing unusually large basal tooth, specimen from Rankin Cave, Jefferson Co., Mo.; 350 X. 33. Hind unguis showing unusually small basal teeth, specimen from Crownover Saltpeter Cave, Franklin Co., Tenn.; 350 X. 34. Habitus, specimen from Mammoth Cave, Ky., setae omitted; 17 X. 35. Apical organ, third antennal segment, specimen from Rankin Cave, Jefferson Co., Mo.; 900 X. 36. Same organ, specimen from Sparkman Cave, White Co., Tenn.; 900 X. 37. Mucro, same specimen; 500 X.

Figures 38-42: paratypes of *P. espana* n. sp. 38. Habitus, setae omitted; 30 X. 39. Mucro; 900 X. 40. Apical organ, third antennal segment; 900 X. 41. Base of hind claw; 900 X. 42. Claw smaller specimen; 900 X.



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with two inner teeth. Both conditions differ in *dubia. Lepidocyrtus decemoculatus* is very poorly described, but every major described feature except the eye number would appear to indicate a separate species. The distribution of the eyes, the shape of the eyepatch, the hinted antennal ratios, and ratio of manubrium to dens all are different from those seen in *dubia.*

In any case, I feel that it is impossible to fit the present form into the descriptions of either species at this time. It is quite possible that close examination will show that this form is in fact synonymous with one or both of the species mentioned above.

Pseudosinella sexoculata Schött

Figures 12-16

Pseudosinella sexoculata Schött 1902. Bib. Kong. Sv. Vet.-Akad. Handl. *28*: 34-5.

Lepidocyrtus sexoculatus Guthrie 1903, Publ. Geol. Nat. Hist. Survey Minn. Zool. Series *4*: 86-7.

P(seudosinella) sexoculata Bonet 1934, Arch. Zool. Exp. Gen. *76*: 370.

Facies typical of genus *Lepidocyrtus*. Background color dull yellow, pigment limited to eyepatches. Head circular, eyes three per side on two separate eye patches, two eyes in front and one behind. Antennae with fourth segment fusiform, second and third segments truncately conical and first segment subcylindrical; third segment strikingly shorter than the second and with an apical organ consisting of two basally constricted oval pegs in a deep fold. Second thoracic segment not strikingly humped, so that the head is prognathous. Fourth abdominal segment about three times as long as the third segment. Unguis without external teeth, the basal pair arising at different levels. Empodial appendage lanceolate with outer margin serrate. Tenent hair large and clearly clavate. Mucro with apical tooth slightly larger than anteapical and markedly upturned at its apex; basal spine exceeding apex of anteapical tooth. Anterior macrochaetae as follows: dorsum of head with a curved row of six setae along each antennal base and a single seta between the two eyepatches on either side; four interantennals, more posterior than normal; a medium pair of setae between and slightly in back of the two posterior eye patches; ventral surface of head with scattered setae along the anterior one-fourth. Second thoracic with a double row of setae along the anterior margin.

Type locality: epigeic greenhouses, Linkoping, Sweden and Rosendal, Norway.

Distribution: a common epigeic form on the Pacific coast. Cave collections in the United States: Reids Cave, Fayette County, Kentucky; and Carlsbad Caverns, Eddy County, New Mexico.

Discussion

This form appears to be a rare troglophile in caves in the United States. Further exploration and collecting in western caves may show it to be more common than presently appears.

Pseudosinella alba (Packard)

Figures 17-21

Lepidocyrtus albus Packard 1873, Peabody Acad. Sci. 5th Ann. Rept: 37.

Sira (Pseudosinella) alba Schäffer 1900, Jahib. Ver. Vaterl. Natur. *56*: 269.

Pseudosinella alba Börner 1901, Zool. Anz. *24*: 707.

Facies typical of genus *Lepidocyrtus*. Background color dull yellow white with scattered bluish or brownish pigment. Eyes two per side on square black pigment patches. Fourth antennal segment fusiform, third segment truncately conical and remainder subcylindrical; third segment noticeably shorter than second and with apical organ of two short subcylindrical pegs. Second thoracic segment slightly enlarged, with head prognathous. Fourth abdominal segment about four times as long as third. Unguis with three inner teeth with basalmost tooth being the largest. The empodial appendage is lanceolate with a small but clear external tooth. Tenent hair clavate. Mucro with apical tooth about twice as long as anteapical and not strikingly upturned; basal spine barely attaining apex of anteapical tooth. Anterior macrochaetae as follows: on the dorsum of head a group of four setae along the base of each antenna, and a group of four interantennal setae forming the corners of a narrow rectangle; in the center are four more setae marking the sides of a triangle which has its apex just anterior to the anterior pair. Ventral surface of head sparsely covered with setae over the anterior median portion. Anterior margin of second thoracic segment with a double row of setae.

Type locality: epigeic but uncertain, probably Massachusetts. A common epigeic form in the United States known from Mystery and Niagra Caves in Fillmore County, Minnestota and Christian Cave in Robertson County, Tennessee.

Discussion

I have examined and measured a considerable number of epigeic forms of this species and can find no significant differences between these and the cave forms. The coloration is the most variable characteristic; some specimens are white save for the eyespots, while all others are almost totally blue.

Pseudosinella gisini, new species
Figures 25-30

Facies typical of genus. Color white with a scattering of blue pigment particularly clear upon the dorsum of the head. Head elongate oval with two eyes per side located upon a single dark eyepatch. Antennae about three and one half times as long as cephalic diagonal with all segments subcylindrical in shape; fourth antennal segment without apical cone and showing definite signs of ringing; third segment with apical organ of two curved, narrow, paddle-shaped setae with supporting rods along one margin. On the opposite side of the apex of third segment are five blunt finger-like setae. Second thoracic segment not humped. Fourth abdominal segment about four times as long as third. Unguis long and curved with external and lateral teeth minute and three inner teeth, basal pair small but clear and on a level, median unpaired tooth minute, visible only under highest magnification. Empodial appendage with slight basal internal swelling. Tenent hair finely clavate. Mucro with teeth subequal, apical tooth not sharply upturned, basal spine heavy, reaching apex of anteapical tooth. Anterior macrochaetae as follows: dorsum of head with four interantennal setae forming the corners of a rectangle, and a row of eight setae forming a straight line along each antenna base; ventral surface with scattered setae over the anterior half of the median and lateral surfaces. Second thoracic segment with two to three rows of setae along the anterior margin and a single row along the lateral margin.

Type locality: Foxhole Cave no. 1, Greenbrier County, West Virginia, VIII-19 '58. Barr coll. Also known from eight additional caves, all in Greenbrier County.

Discussion

The most prominent variation seen in the species concerns the median unpaired tooth of the unguis which may be entirely absent. In such forms the tenent hair is very weakly clavate so that this is visible only under highest magnification and with phase contrast. Although the typical form of this species is strikingly distinct from the typical form of *P. hirsuta* there are some specimens of the latter species which approach *gisini* in one or more characteristics (see discussion under *P. hirsuta*); however, the two can always be distinguished on a basis of the cephalic chaetotaxy and the tenent hair.

Pseudosinella petterseni Börner

Pseudosinella petterseni Börner 1901, Zool. Anz. *24*: 707-8.

Facies typical of genus. Color silvery white without trace of pigment. Head circular and eyeless. Antennae with fourth segment fusiform, third segment truncately conical and remainder subcylindrical; apex of fourth segment rounded; apical organ of third segment with two subcylindrical pegs. Second thoracic segment not humped and the head prognathous at rest. Fourth abdominal segment about three and one half times as long as the third segment. Unguis with a small external tooth, and three well developed internal teeth; the basal pair not on a level and the basalmost one considerably larger than the remainder. Empodial appendage with a large outer wing tooth on a distinct lamella. Tenent hair strikingly clavate. Mucro with apical tooth twice as long as anteapical; basal spine exceeding the apex of anteapical tooth. Anterior macrochaetae as follows: dorsum of head with a row of six setae along each antenna base, the setae in each row being alternately large and small, the posteriormost seta of each row is displaced inward; interantennal setae are concentrated near the anterior margin of the head so that only two are clearly visible; ventral surface with scattered large setae on anterior one third of surface. Anterior margin of second thoracic segment with from two to four rows of setae.

Type locality: epigeic, Frauenberg bei Marburg, Germany.

Distribution: one of the commonest epigeic species in the United States; known in caves from Kendall and Burnett Counties, Texas, and Linn County, Iowa.

Discussion

The specimens seen from the Texas caves differ slightly from the epigeic forms seen in most of the country; in the former the basal ungual tooth is smaller, the tenent hair clavate and the basal spine of the mucro shorter; however, these variations are probably geographical since epigeic specimens seen from New Mexico indicated similar modifications. Further collections from western caves will probably show this to be a much more common cave inhabitant than is presently indicated.

Pseudosinella argentea Folsom

Figures 31-37

Pseudosinella argentea Folsom 1902, Psyche *9*: 366.
P(seudosinella) decipiens (?) Bonet 1934, Arch. Zool. Exp. Gen. *76*: 370-3.

Facies typical of genus. Color white with scattered blue pigment particularly upon head. Head almost round when seen from above, often with traces of pigmentation on eyespot region; eyeless; antennae with third segment sub-conical in shape; fourth antennal segment much shorter than cephalic diagonal and with apex rounded, without apical cone. Apical organ of third segment of two strongly curved blunt pegs with an additional pointed peg off to one side. Thorax not humped and head prognathous. Fourth abdominal segment about four times as long as the third segment. Unguis with one or both basal teeth enlarged and a single median tooth prominent and projecting. Empodial appendage lanceolate with a very small external tooth. Tenent hair weakly clavate. Mucronal teeth subequal and basal spine attaining the apex of the median tooth. Anterior macrochaetae as follows: dorsum of head with four interantennal setae arranged in a narrow rectangle and with a small seta located in the center of this rectangle. Antennal bases with seven setae arranged 6-1 in a straight line along the base. Venter of head with a few scattered setae near the anterior margin. Second thoracic segment with three to four rows along the anterior margin and a single row of smaller setae along the lateral margin.

Type locality: a grave, Washington, D. C. Range: known from caves in Missouri, Central Tennessee, and single localities in Kentucky, Virginia, Arkansas, Georgia and Washington, D. C.

Discussion

This species is almost as variable as *P. hirsuta* and in some forms the basic structure is very similar. The two species can always be sep-

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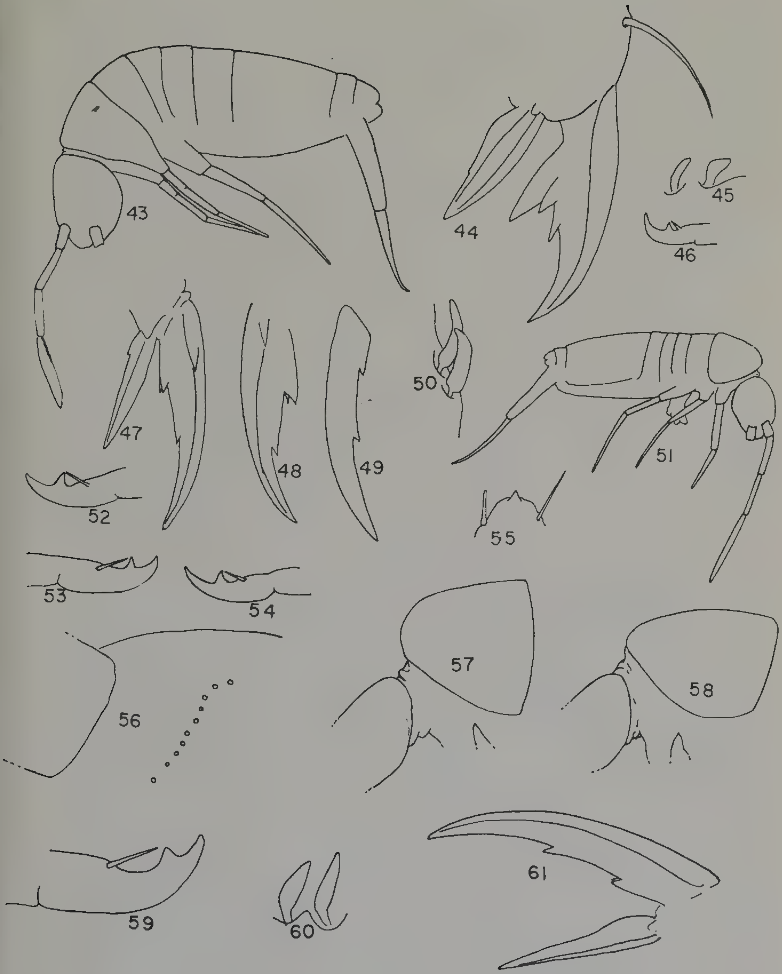
EXPLANATION OF PLATE 3

Figures 43-46: holotype of *P. orba* n. sp. 43. Habitus, setae omitted; 30 X. 44. Hind claw; 500 X. 45. Apical organ, third antennal segment; 900 X. 46. Mucro; 500 X.

Figures 47-58: *P. hirsuta*. 47. Hind claw, specimen from Ward Cave, Bedford Co., Tenn.; 350 X. 48. Unguis, another specimen same locality; 350 X. 49. Hind unguis, specimen from Mill Creek Cave, Davidson Co., Tenn.; 250 X. 50. Apical organ, third antennal segment, same specimen as fig. 47; 900 X. 51. Habitus, topotype; 18 X. 52. Mucro, same specimen as fig. 47; 900 X. 53. Mucro, topotype; 900 X. 54. Mucro, same specimen as fig. 49; 900 X. 55. Apical cone fourth antennal segment, specimen from Piper Cave, Smith Co., Tenn.; 900 X. 56. Antennal base setae, same specimen; 250 X. 57. Thoracic profile, specimen from Gassaway Cave, Metcalfe Co., Ky.; 30 X. 58. Thoracic profile, specimen from Pratt Cave, Pickett Co., Tenn.; 30 X.

Figures 59-61: *P. spinosa*. 59. Mucro, specimen from Jared Hollow Cave, Putnam Co.. Tenn.; 900 X. 60. Apical organ, third antennal segment, specimen from Payne Saltpeter Cave, Grundy Co., Tenn.; 900 X. 61. Hind claw, same specimen; 250 X.



CHRISTIANSEN — PSEUDOSINELLA

arated on a basis of the cephalic chaetotaxy and the apex of the antenna. The variations of the unguis structure are most striking. Typically the median tooth is large, but it may be small (see figures); also the basal teeth are normally staggered and of different sizes, but they may be of equal size and/or at the same level. The external tooth is usually present but may be folded and virtually invisible. A small apical tooth may be present. The tenent hair varies from strikingly clavate to acuminate. Some forms are totally without pigment while others are clearly colored. The cephalic diagonal, fourth antennal segment and head also vary considerably in size. The antennal base setae also vary with size (as is normal for the genus) but the huge majority of specimens examined had the number noted.

First examination of this material led to the belief that two or three species were involved; but, with larger series of specimens from many localities and careful analysis of the variation, it became apparent that no clear boundaries could be drawn within the whole group and that the combinations of characteristics were virtually at random. It appears that some of the variation is geographic in nature (example: large median tooth more common in northern populations) but an analysis of this must await further and more complete collections.

Specimens taken from caves in Virginia and identified by Bonet as *P. decipiens* (1934) are almost certainly *argentea*. It is quite possible that *P. argentea* is in fact synonymous with *P. decipiens*. The unguis in particular appears to have much the similar sort of variation in the European forms as in *argentea*. The figures for this species given by Denis, Bonet and Gisin would appear to indicate considerable variation; however, there are certain striking differences. First, in *argentea* a common form has both teeth arising at the same level, and this apparently is never true with *decipiens*. Second, Denis indicates the apical organ of the third antennal segment in *decipiens* as consisting of two cylindrical, straight pegs, whereas in *argentea* they consist of two basically constricted, strongly curved elliptical pegs. The fourth antennal segment is relatively longer in *argentea* than Bonet indicates for *decipiens*, and the fourth abdominal segment is from four to five times as long as the third rather than 3 to 3.5 times longer as indicated by Bonet for *decipiens*. In view of all of these I feel it wiser to maintain *argentea* until such time as a careful comparative study can be made between this form and *decipiens*.

Pseudosinella folsomi Denis

Figures 22-24

Pseudosinella folsomi Denis 1931, Mitt. Mus. Hamburg *44*: 226-8.

Facies typical of genus. Color white without vestige of pigment. Head round, eyeless. All antennal segments subcylindrical; apex of fourth segment blunt; apical organ of third segment with two large elliptical pegs, constricted basally. Second thoracic segment slightly humped, head more or less prognathous. Fourth abdominal segment about three times as long as third. Unguis with only two strong basal internal teeth, arising at about same level and with one greatly enlarged. Empodial appendage with inner margin slightly truncate, and outer margin equipped with a prominent tooth on a distinct lamella. Tenent hair short and clavate. Mucro with apical tooth slightly longer than anteapical; basal spine not attaining apex of anteapical. Anterior macrochaetae as follows: dorsum of head with a group of five at each antenna base and four interantennals. Another pair of setae can be seen near the lateral margins of the middle of the dorsum; ventral surface with numerous scattered setae on the anterior third of the lateral and median portions. Anterior margin of the second thoracic segment with four to five rows of setae and a single row along the lateral margins.

Type locality: epigeic "Station No. 36," Massachusetts. Also recorded as an epigeic form from several places in the vicinity of Boston and New Orleans. Cave distribution: known only from Limberlost Valley Cave, Newton County, Missouri.

Discussion

Recent collections from South America would seem to indicate that this species is widespread in Chile at least. The fact that the epigeic collections in the United States have been limited to the vicinity of major ports makes it seem probable that this is an imported form here. Its one collection in a cave was in association with another troglophile species, *Sinella caeca*. Further collections will have to be made before anything can be said about the significance of this invasion.

Pseudosinella espana, new species

Figures 38-42

Facies typical of genus. Color white without trace of pigment. Head oval, eyeless. Antennae one and one half times as long as cephalic diagonal, with the first three segments subcylindrical and fourth segment ellipsoidal; apical organ of third segment with two paddle-shaped setae having central supporting rods. Second thoracic segment not strikingly humped. Fourth abdominal segment slightly more than three times as long as third. Unguis narrow and sickleshaped with only two large basal internal teeth. Empodial appendage with a basal internal swelling and a large external tooth upon a distinct lamella. Tenent hair small and acuminate. Mucro with apical tooth gradually curved and more than twice as long as anteapical; basal spine absent. Anterior macrochaetae as follows: dorsum of head with five interantennal setae and a row of six setae near each antenna base and a pair near the center of the dorsal field; a diagonal row of three and group of four setae near each latero-posterior margin of the dorsum; ventral surface with two mid-lateral patches of densely packed setae. Second thoracic segment with three to four rows of setae along the anterior margin and a single row along the lateral margins.

Type locality: Old Spanish Cave, Stone County, Missouri, VI '59, Tecklin, Darland, and Hedges coll. Also known from Coleman's Cave, Montgomery County, Tennessee. It is probably widespread but uncollected in caves between these two points.

Discussion

This species is the only Nearctic member of the genus to lack a basal spine. Except for this remarkable feature it is very similar to *P. folsomi* although it shows a number of cave adaptions not found in this last species.

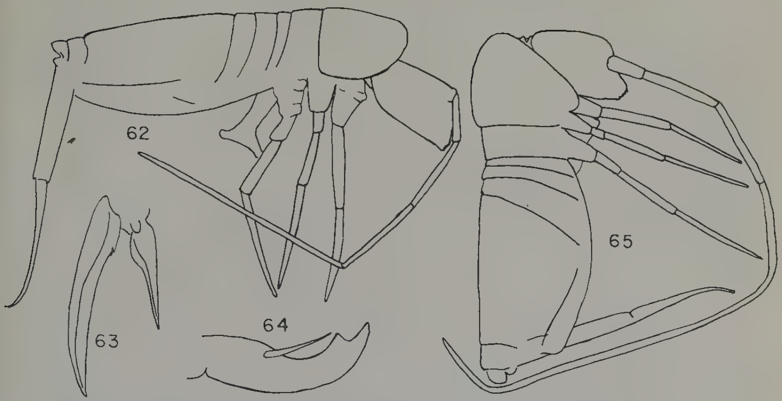
Pseudosinella orba, new species

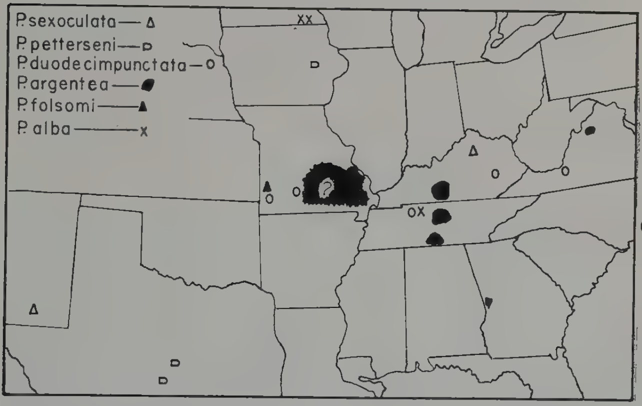
Figures 43-46

Facies typical of genus. Color white without trace of pigment. Head circular, eyeless. Antennae about twice as long as cephalic diagonal, all segments slightly ellipsoidal; second and third segments subequal in size; apical organ of third segment with two blunt oval pegs. Second thoracic segment slightly humped. Fourth abdominal segment about three times as long as third. Unguis broad, apically slightly hooked, basal internal teeth large, subequal, and arising well above the base of the claw; median unpaired tooth prominent and about at mid-level of unguis; a pair of small lateral teeth are near the base. Empodial appendage lanceolate, with external margin serrate and basally expanded. Tenent hair slender and acuminate.

EXPLANATION OF PLATE 4

Figure 62: *P. spinosa,* Habitus, specimen from Payne Saltpeter Cave, Grundy Co., Tenn., setae omitted; 18 X. Figures 63-65: *P. boneti* n. sp. 63. Habitus, holotype; 18 X. 64. Mucro, holotype; 350 X. 65. Hind claw, paratype; 250 X. Figure 66: Map showing known cave locations of six troglophile species of *Pseudosinella* in the U. S. Figure 67: Map showing cave distribution of seven troglobite species of *Pseudosinella* in the U. S.





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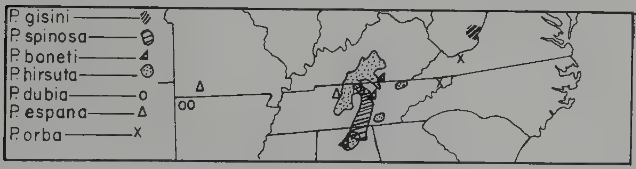

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CHRISTIANSEN — PSEUDOSINELLA

Mucro with apical tooth much larger than anteapical; basal spine slender but reaching the apex of the anteapical tooth. Anterior macrochaetae as follows: dorsum of head with an interantennal pair, and then in the anterior half of the median field six more arranged along the sides of a triangle with its apex near the interantennals; a straight row of eight setae along each antenna base; ventral surface with scattered setae along the anterior third. Second thoracic segment with two rows along the anterior margin and a transverse row of eight setae along the posterior margin.

Type locality: Morril Cave, Sullivan County, Tennessee. X '56. T. Barr coll. Also taken from Hamilton Cave, Bland County, Virginia.

Discussion

This striking species is quite unique in the chaetotaxy of the head and the structure of the unguis. In both characteristics it appears to be related to *P. alba* and may well represent a cave derivative of this species. The fact that the modifications for cave life are relatively slight makes it entirely possible that this is in fact a troglophile form which is so far undescribed from epigeic habitats.

Pseudosinella hirsuta Delamare (new combination)

Figures 47-58

Troglosinella hirsuta Delamare 1949, Notes Biosp'e., *4*: 121-2.

Facies typical of genus. Background color yellowish white with slight touches of blue or reddish (?) pigment, particularly in the region of the antennal bases. Head elliptical, normally without eyes. Antennae elongate with all segments subcylindrical; fourth segment usually showing signs of ringing with a definite small conical projection at the apex; apical organ of third segment with two curved elliptical paddles, constricted basally. Second thoracic segment slightly humped. Fourth abdominal segment about six times as long as the third. Unguis elongate with a small external and three small internal teeth, the basal pair being on the same level. Empodial appendage narrow and lanceolate with a small external tooth. Tenent hair small and acuminate. Mucro with apical tooth about twice as long as anteapical and weakly upturned at the apex; basal spine just reaching the apex of the anteapical tooth. Anterior macrochaetae as follows: dorsum of head with an interantennal group marking the corners of a narrow rectangle; a row of nine setae along each antenna base with the posterior one or two in each row displaced inward; ventral surface with scattered setae along the anterior half. Two to three rows of setae along the anterior margin of the second thoracic segment.

Type locality: Tennessee caverns, Tennessee, H. Henrot coll. Distribution: major distribution in south-central Kentucky, central Tennessee and northeast Alabama; isolated populations in eastern Tennessee and Kentucky.

Discussion

This species is the most abundant and most variable troglobite form of the genus in North America. No single description can apply to all of the available specimens, but the characteristics listed above apply to about 60% of the specimens and with one or another major alteration would fit all save about 1% of the specimens seen. The variation is extensive and can be seen in virtually all characteristics so that some specimens resemble *P. argentea* while others are superficially similar to *P. gisini*; indeed single specimens are often hard to place. Analysis of the variable characteristics shows that they are definitely geographically determined; however, since there is no similarity among the distribution of the various characteristics, the subspecies concept is clearly not applicable.

In general there are six characteristics which vary strikingly and these and their limits of variation are listed below:

A) Second thoracic segment, strongly humped to virtually flat.
B) Unguis, condition seen in *argentea* to condition seen in *gisini*.
C) Empodial appendage, lanceolate to clearly basally expanded.
D) Ratio of fourth antennal segment to cephalic diagonal, 3:6-5:3.5.
E) Mucro, anteapical tooth middle to near apical tooth.
F) Eyes, eyeless to two eyes per side.
G) Pigment, totally white to head and thorax medium blue.

All in all the majority of the specimens are very similar to the form in the description and no one specimen carries very many of the variant characteristics.

Pseudonsinella spinosa Delamare (new combination)
Figures 59-62

Troglosinella spinosa Delamare 1949, Notes Biosp'e., *4:* 122-4.

Body elongate with attenuate appendages. Background color dull yellowish white with occasional flecks of reddish (?) pigment around the bases of the antennae. Head elliptical, strikingly longer than broad. Antennae with all segments subcylindrical, and fourth segment showing signs of ringing and subsegmentation; apex of antenna with a small apical cone; apical organ of third segment with two flattened, fusiform, basally constricted paddles, in separate shallow folds. Second thoracic segment strongly humped forcing head into an opisthognathous position. Fourth abdominal segment about seven times as long as third. Unguis strikingly elongate, without external teeth but with three very small internal teeth, the basal pair being on a level and slightly smaller than the median unpaired tooth. Empodial appendage lanceolate, slender and with a striking internal basal expansion. Tenent hair small and acuminate. Mucro with anteapical tooth displaced toward apex; teeth subequal in size; basal spine not attaining level of anteapical tooth. Dens with one or two rows of heavy finely ciliate spines along anterior two thirds. Anterior macrochaetae as follows: dorsum of head with an interantennal group of five setae; a curved row of nine setae along each antennal base; ventral surface covered with numerous setae. Second thoracic segment with two to three rows of setae along anterior margin and a single row along the lateral margins.

Type locality: Alladin's Cave, Madison County, Alabama, H. Henrot coll. Distribution: limited to central Tennessee and northeast Alabama. Abundant within these limits.

Discussion

This is by far the most stable of the common troglobite species of this genus. The only striking variation is seen in the mucro, which has occasional populations with the anteapical tooth much more basal than is normal. Other variations are minor; for example, some forms are entirely white while others have a scattering of pigment over the whole body. The inner ungual teeth are often so minute as to be invisible under low magnifications. The dental spines are often difficult to observe.

Pseudosinella boneti, new species

Figures 63-65

Body elongate, appendages very attenuate. Color white without trace of pigmentation. Head oval without eyes. Antennae four or more times as long as head with all antennal segments subcylindrical; apical organ of third antennal segment with two paddle-shaped setae having the supporting rod along one margin. Second thoracic segment greatly enlarged, forcing the head into a hypognathous or opisthognathous position. First abdominal segment strikingly compressed; fourth abdominal segment almost seven times as long as third. Unguis extremely thin and elongate having only a single pair of internal basal teeth. Empodial appendage thin and basally swollen. Tenent hair minute and acuminate. Dens without spines. Mucro with apical and anteapical teeth close together and near apex, subequal in size; basal spine not attaining level of anteapical tooth. Anterior macrochaetae as follows: dorsum of head with seven interantennal setae and a row of eight setae along each antenna base; ventral surface with numerous densely packed setae along median and lateral area. Anterior margin of second thoracic segment with two to three rows of densely packed setae.

Type locality: Pomps Cave, White County, Tennessee, III '57 T. Barr coll. Also taken from Dairyhouse Cave in the same county; Wolf Cave, Morgan County, Alabama; and Wind Cave, Pulaski County, Kentucky.

Discussion

This well marked species represents the apogee of cave evolution in the Nearctic *Pseudosinella*. The series available is limited and little variation has been seen. In some forms the ungual teeth are entirely absent, and in the specimens from Alabama and Kentucky the median tooth of the mucro is less apical than in the Tennessee specimens. The specimens from Kentucky sometimes have a very small median internal ungual tooth.

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THE IMMATURE STAGES OF *BORIOMYIA FIDELIS* (BANKS) WITH TAXONOMIC NOTES ON THE AFFINITIES OF THE GENUS *BORIOMYIA* (NEUROPTERA:HEMEROBIIDAE)

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Introduction

The genus *Boriomyia* Banks, 1904 (*sensu* Killington, 1937, Carpenter, 1940; *nec* Banks, 1905, Tjeder, 1941, *et seq.*) is known only from the Nearctic Region where it is represented by the type species *B. fidelis* (Banks) and by *B. speciosa* (Banks). To date the biology of the immature stages of neither of these species has been elucidated. *B. fidelis* has been taken with fair frequency in the middle Atlantic states and the author has made several attempts to rear this interesting hemerobiid; however, it has only been recently that this effort has met with any success. Although this study represents a portion of a more general investigation of the morphology and ecology of the immature stages of the Nearctic Neuroptera, it seems desirable to publish these notes at this time because of their bearing on the question of the relationship of *Boriomyia* to the other genera of the Hemerobiidae.

The writer wishes to express his gratitude to Mr. Ivan Huber of the Food and Drug Administration, Department of Health, Education and Welfare, who supplied the author with several living females, including the all-important specimens whose offspring form the basis for this account.

Methods

The immature stages which were utilized in this study were derived from three females collected in College Park and Greenbelt, Prince Georges Co., Md., in 1956 and 1958. After rearing and preservation, thirty-seven first instar larvae, ten second instar larvae, eighteen third instar larvae and two pupae were available for morphological investigations. Although this species can be identified from either sex of the adult with good reliability, the best taxonomic characters are found in the genitalia of the male. Accordingly, three pupae, the offspring of a single female, were allowed to transform and two of these produced males by which the initial identification of one of the original females was confirmed. These identifications were made by the writer utilizing the key of Carpenter (1940).

Past experience with numerous types of Neuroptera has indicated that when eggs can be obtained from field-collected females, these eggs are fertile. The usual procedure for inducing oviposition by such females has been to confine the insect in some suitable container. Thus Smith (1922) was quite successful in securing eggs from females of various Nearctic species of *Chrysopa* by placing them in lamp-chimney cages over growing, aphid-infested plants, the aphids serving as food for the female and possibly also as an oviposition stimulus. Killington (1937) utilized much the same procedure in obtaining eggs from many species of British hemerobiids.

Although this method was tried by the present writer, the inspection of so large a volume for the infrequent eggs supplied by the females of *B. fidelis* proved difficult. In addition, the broadly oval wings of this species with their numerous macrotrichiae render the insect somewhat clumsy and almost any confined space serves to trap the female, the leaf axils of the plants serving especially well in this respect.

A more satisfactory arrangement was found by confining the females individually in 75 x 25 mm. cotton-stoppered glass vials. Humidity was supplied from a small pleget of cotton, dampened with a solution of sucrose and water which was placed in the bottom of the vial. To obviate the possibility of the female becoming stuck to the wet cotton, a cardboard partition was placed between the damp cotton and the female and this was removed only for a short time each day to permit the female to drink. Small nymphs of the aphid *Macrosiphum liriodendri* (Monell) collected from nearby tulip trees (*Liriodendron tulipifera* (L.)) were supplied on a small piece of leaf daily.

Eggs, which were invariably laid on the cotton plug of the oviposition vial, were removed as soon as detected and placed singly in 40 x 13 mm. cotton-stoppered shell vials. Larvae were supplied each day with nymphs of the same aphid as was fed to the adults. This food was introduced into the vial on a piece of fresh leaf which probably served to maintain a reasonable humidity although no attempt was made to control or record this variable. Small wads of damp cotton were placed in the vials after the cocoons had been spun in order to prevent excessive dryness; however, these were not placed in vials with larvae in order to eliminate any possibility of the larvae becoming trapped and drowning. These rearings were carried out in a room open to the usual fluctuations in the summer temperatures which occurred during the periods of this study (June 25-August 8, 1956, and June 19-July 18, 1958).

Color notes were made from microscopic observations of living larvae and these were supplemented by color photographs taken of freshly killed larvae. The drawings of Plates 5 and 6 were prepared by the author from these notes, from material fixed in Peterson's KAAD fluid (see Peterson, 1953, for details of preparation) and stored in alcohol, and from the examination of cleared specimens in temporary glycerine mounts with a binocular dissecting microscope and with a phase-contrast compound microscope. All measurements were made with an ocular micrometer calibrated with a stage micrometer. All indices of dispersion given in this paper are standard errors of the mean.

Description of The Developmental Stages

Oviposition and embryonic development — The three females used in this study were confined for periods of nine, fifteen and twenty-two days, during which times a total of ninety-four eggs was deposited. These were produced in a series of small lots which, with one exception, contained between one and eight eggs ($\bar{x} = 3.53 \pm 0.53$ eggs/lot). In a single instance a freshly caught female, whose abdomen was noted to be tremendously swollen with eggs, laid twenty-seven eggs during her first twenty-four hours of confinement. Subsequent to this, however, the egg production of this female fell within the limits noted above. In all cases oviposition occurred at night and was never observed by the writer.

In addition to the ninety-four eggs produced by these females, the remains of an undetermined number of other eggs were noted which had, apparently, been partially consumed by the females. Six of the ninety-four eggs regarded as normal may also have been damaged by one of the females as these were slightly distorted in shape when first seen and none of them showed any signs of embryonic development. Three additional eggs although seemingly normal in all respects also failed to show any indication of development. Of the eighty-five eggs which showed apparent normal development, two failed to hatch.

Egg — Approximately ellipsoid in shape, distinctly flattened on surface attached to substratum. Color, a pale greyish-yellow, becom-

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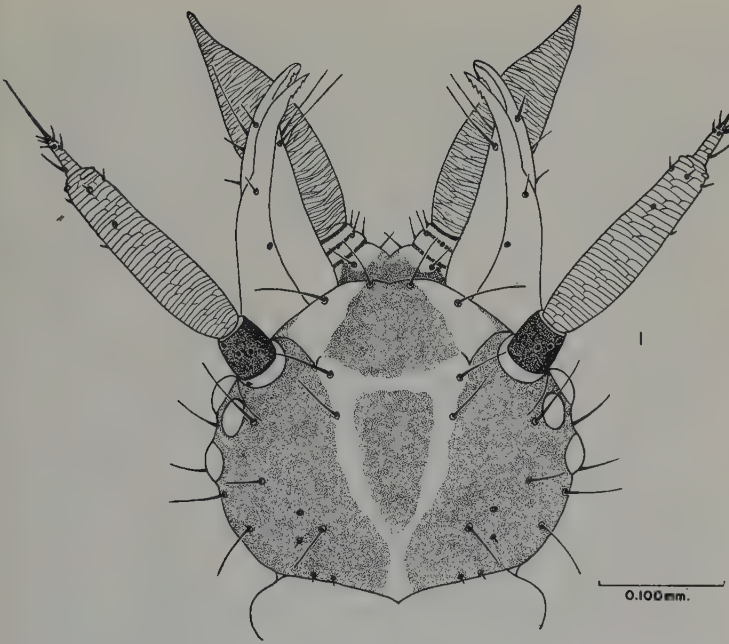
Explanation of Plate 5

Fig. 1. Facies of head capsule of first instar larva, dorsal view.

Fig. 2. Head capsule and prothoracic "collar" of third instar larva, dorsal view.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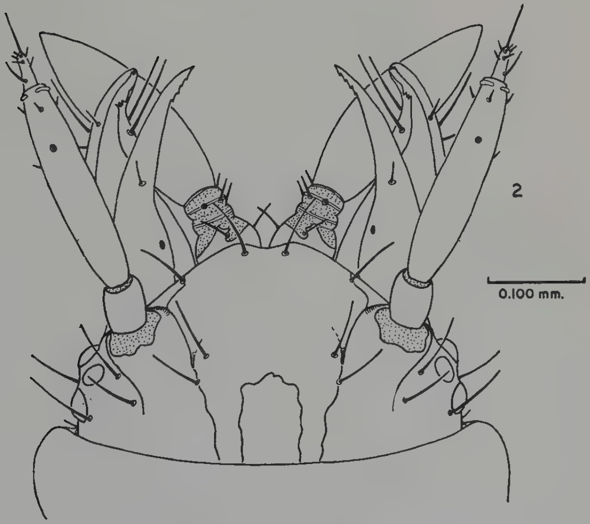
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MacLeod — Boriomyia

ing greyish-brown as embryo develops. Micropyle sessile, flattened, chalk-white; a minute depression in center. Chorion, apparently smooth, but showing a minutely granulate texture at a magnification of 60X giving the impression of finely frosted glass. At higher magnifications an irregular imprinted pattern visible, attributed to the pressure of follicular cells of ovary by Killington (1946). Minute elevations and tubercles of chorion reported for several other hemerobiid genera by Killington (1936) lacking in *B. fidelis*. Size of a single unhatched egg: length — 0.7752 mm., greatest width — 0.3420 mm.

The eyes of the embryo become visible through the chorion after four days, while hatching takes place after about seven and one-half days of development ($\bar{x} = 7.6 \pm 0.1$ days, N = 70). As with other Neuroptera, emergence from the chorion is assisted by an eggburster (figs. 5, 6) which forms a longitudinal ridge-like projection from the embryonic cuticle in the region of the clypeus. In a series of eggbursters derived from seven siblings which were studied in detail, the number of small teeth along the distal margin of the blade was found to vary between twenty-two and twenty-nine ($\bar{x} = 25.0 \pm 0.9$). The two extremes are figured in figs. 5 and 6.

First instar larva (figs. 1, 3) — *Head capsule* ellipsoid, prominent, as wide as widest part of body; of a uniform grey color dorsally, this interrupted medially by a Y-shaped ecdysial cleavage line passing down to clypeal margins just medial to bases of jaws on either side; anterior, diverging arms of cleavage line cross connected by transverse area of pale cuticula at level of anterior tentorial pits delimiting a proximal frontal area and a distal clypeal area. Ocular area of head capsule antero-lateral, consisting of three, clear corneal swellings. Anterior two corneae each with one dark ommitidial element beneath; three additional ommatidiae visible beneath posterior cornea. Latero-ventral surface of head capsule with usual pair of dark fuscous lines; the more dorsal, running between posterior tentorial pit and dorsal articulation of mandible, representing the subgenal sulcus, the more ventral, running from vicinity of posterior tentorial pit to maxillary component of jaw, representing cardo and stipes. Ventral surface of head capsule largely covered with shield-shaped mental region of labium.

Antenna three segmented, short, reaching only to tip of extended jaws. Basal segment dark, fuscous; short, only slightly longer than wide. Second segment comprising most of length of antenna, about five times as long as first segment. Third segment short, peg-like, approximately of same length as basal segments; surmounted by a terminal seta slightly longer than segment itself. Distal two segments pale grey, showing usual irregular pattern of annular sclerotizations characteristic of antennae of hemerobiid larvae (fig. 1). *Jaws* slightly curved inwards; pale grey toward base, becoming dark brown for distal one-third of length. *Labial palpi* three segmented. Basal segment short, slightly wider than long; arising from largely fuscous, mound-like palpigeral swelling on antero-ventral surface of head capsule. Second segment of same shape as first segment. Both of basal two segments braced by a mid-segmental thin, dark, sclerotic ring. Distal segment of palpus elongate, inflated, reaching well beyond tips of jaws when extended forwards. Surface of distal palpal segment covered with same irregular pattern of annular sclerotizations found on distal two segments of antenna. Base of distal palpal segment braced by a thin fuscous ring.

Thorax — Prothorax with usual three subdivisions. Anterior subsegment short, transverse, forming a collar which overlaps posterior margin of head capsule only slightly. Posterior subsegment of prothorax with spiracle opening on lateral surface. Mesothorax with two subdivisions, metathorax consisting of leg-bearing portion only. Leg-bearing portions of thoracic segments with latero-dorsal sclerites reduced to mere vestiges, easily visible only upon examination of cleared specimens with phase microscope.

Legs largely pale except for thin fuscous sclerotizations partially encircling distal end of each coxa and each femur and proximal margin of each tibia. Pretarsus of all legs with usual clavate empodium extending from between the pretarsal claws.

Abdomen consisting of ten segments; first eight segments membranous, with a spiracle located laterally on each segment. Segment nine with a sclerite covering most of dorsal surface. Tenth abdominal segment largely covered with four small sclerites, one dorsally, one ventrally and one on each side. A pair of eversable pygopods contained within posterior portion of this segment.

Cuticle of thoracic and first eight abdominal segments of unfed larva a light pinkish-purple color through which color of body contents shows through as a light greenish-yellow background. Color of this background changing with the intake of food to an orange hue and then to a dark reddish-orange extending from middle of prothorax to second abdominal segment. Abdominal segments nine and ten pale grey throughout the first larval stadium with their sclerites just visible under a dissecting microscope. Aorta at first only faintly visible between anterior prothorax and eighth abdominal segment, toward end of stadium becoming outlined by small isolated patches of developing fat body on either side of aorta. Fat body particularly well-developed in posterior subsegments of pro- and mesothorax.

Duration of first larval stadium — 3.4 ± 0.7 days (N = 33)
Length of unfed first instar larva (measured from clypeal margin of head capsule to posterior margin of dorsal sclerite of tenth abdominal segment) — 1.57 ± 0.12 mm. (N = 6)
Maximum width of head capsule (measured across ocular areas) — 0.3018 ± 0.0009 mm. (N = 7)

Subsequent development of B. fidelis — The head capsules of the second and third instar larvae (fig. 2) are quite similar to each other and differ from that of the first instar larva principally in being slightly wider in proportion to their lengths, which, combined with a lack of the curvature of the lateral margins of the head present in the first instar larva, gives the dorsal aspect of the head capsule a distinctly more quadrate appearance. In addition, the formerly fuscous regions of the clypeal area dorsally and the mental region of the labium ventrally of the first instar larva are pale in the subsequent larval instars so that only the frontal and parietal areas are darkened in these stages. The labial palpi are somewhat less inflated in appearance in the second and third instar larvae although they remain stouter than is usual in this family and reach well beyond the tips of the extended jaws.

The pretarsi of all legs of the second and third instar larvae lack the empodium present in the first instar larva, its place being taken by a delicate, fan-like arolium, arising from the dorsal surface of the pretarsus. Posteriorly, the tergal area of the nineth abdominal segment is no longer covered by a distinct sclerite in the second and third instar larva.

The body form of the second and particularly the third instar larva (fig. 4) becomes progressively swollen and grub-like with the development of a complex series of projecting lobes on the original segments of the body. The anterior subsegment of the prothorax remains short and collar-like and the head capsule becomes increasingly retracted within this portion of the body, so that although the head can be extended, the usual condition in which to find a living larva is with the head withdrawn within the prothorax as far anteriorly as the bases of the antennae.

The body pattern visible to the eye is the result of the interplay between three somewhat variable features. The integument is lightly pigmented by a mottled pattern of a diffuse, purple color which overlies a much darker reddish-purple color due to the gut contents and hemolymph. Between these regions, the rapidly developing fat body creates an intricate series of patches which are nearly pure white in regions where the cuticle is faintly pigmented and which show as darker purple areas where the cuticle is more darkly pigmented. The exact pattern which the larva presents depends largely on the extent of the development of the fat body which gradually fills most of the available space of the hemocoel. One constant feature of this pattern is the presence of two white transverse bands across the body on the posterior subsegments of the prothorax and mesothorax due to the near lack of cuticular pigment in these regions. Ventrally the palpigers consistently include a small portion of the fat body within them which shows through the clear cuticle as a snow-white patch. In a dorsal view of a fully mature third instar larva (fig. 4) the fat body will be seen to have ramified throughout the body leaving only paired lateral "windows", from the posterior margin of the prothorax through the sixth abdominal segment, and the aorta in the dorsal midline through which the darker color of the hemolymph shows through.

A typically hemerobiid cocoon is spun by the third instar larva. This consists of a loose network of silk strands within which is located a more-compact inner cocoon which is, nevertheless, open enough to permit easy observation of the final stages of development. Pupation, metamorphosis and the eclosion of the adult all occur without any apparent cessation of development. The pupa is typical of that of many hemerobiids studied by the writer and, so far as can be ascertained, possesses no prominent features peculiar to *Boriomyia*. Post first instar development may be summarized as follows:

- Measurements
  - Length
    - mature second instar larva — 3.32 ± 0.43 mm. (N = 5)
    - mature third instar larva — 4.53 ± 1.05 mm. (N = 5)
  - Maximum width of head capsule
    - second instar larva — 0.3426 ± 0.0063 mm. (N = 4)
    - third instar larva — 0.4073 ± 0.0087 mm. (N = 3)
- Developmental times
  - second instar larva — 3.5 ± 0.7 days (N = 20)

third instar larva —
  prior to spinning cocoon — 4.5 ± 0.1 days (N = 4)
  post spinning — 6.9 ± 0.4 days (N = 4)
pupa — 10.7 ± 0.4 days (N = 3)

Behavioral and ecological notes — The young first instar larva is the only stage which is really active in the sense of seeking out prey. The older first instar larva and particularly the second and third instar larvae tend to remain immobile in some corner of the vial, a favored site for this position being between the cotton plug and the side of the vial. Aphids which move too close to the larvae are seized by a quick upward thrust of the jaws from below. The prey does not seem to be sucked as thoroughly as has been observed to occur with various species of *Hemerobius* and *Micromus* with which the author has worked. In these genera the prey is manipulated by the larva until the jaws have probed into every available corner of the body. The larvae of *B. fidelis* seem to simply suck the immediately available fluids of the prey with only incidental movement of the aphid.

One behavioral trait of the adult deserves some comment because of its bearing on the question of the affinities of *Boriomyia* discussed below. When at rest, the adult consistently assumes a distinctive position by placing the anterior surface of the head flat against the substratum with the antennae directed posteriorly between the legs and neatly clasped by both pairs of palpi. In many respects this position is reminiscent of the death-feigning position which many Neuroptera will assume if startled suddenly by a sharp vibration, although in this case the insect drops to the ground and lies on its side and even though the antennae are directed posteriorly beneath the body, they are not clasped by the palpi.

The natural ecology of this insect remains almost completely unknown as the writer has yet to locate any of the immature stages in the field. Of possible interest in terms of the habitat of this species is a collection of three males and two females taken in a short time in an open pine woods near Charleston, S. C. These were captured on April 20, 1957, and I am informed by the collectors, Messers. Ivan

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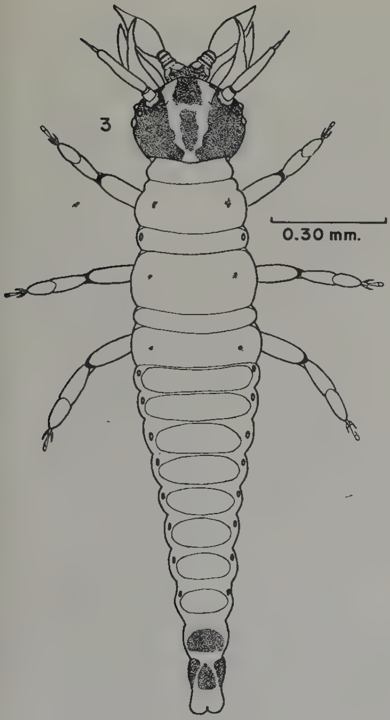
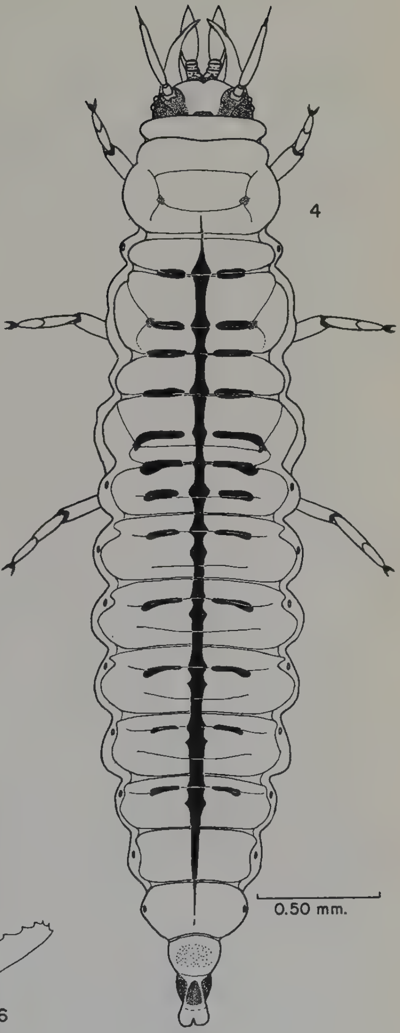
Explanation of Plate 6

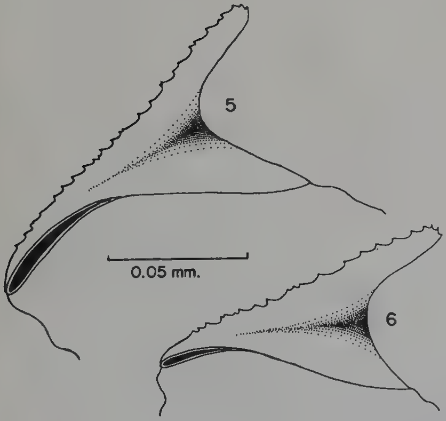
Fig. 3. First instar larva, dorsal view.

Fig. 4. Mature third instar larva, dorsal view. The latero-dorsal sclerites of the larvae shown in figs. 4 and 5 are depicted as seen by the microscopic examination of cleared specimens. In life these sclerites are nearly invisible.

Figs. 5 and 6. Egg bursters, showing extremes in the number of teeth, lateral view.







MacLeod — Boriomyia

Huber and Paul E. Spiegler, that the insects seemed to be associated with piles of dead branches of yellow pine (*Pinus australis* Michx.) on the ground.

The Taxonomic Status of *Boriomyia*

A series of nomenclatorial mistakes combined with several taxonomic errors in evaluating published descriptions have obscured the true relationships of this genus within the Hemerobiidae. The name *Boriomyia* appeared for the first time in 1904 when Banks included his previously described species *Hemerobius fidelis* and *H. speciosus* under this generic name. A formal description of *Boriomyia* as a new taxon appeared in 1905 in Banks' Revision of the Nearctic Hemerobiidae. In this work, six Nearctic species were included in this genus in addition to *B. fidelis* and *B. speciosa,* one of these, *H. disjunctus* Banks, being designated as the type species. Subsequently additional Nearctic and numerous exotic species were referred to *Boriomyia* by various workers. In 1930 Banks, recognizing that *B. fidelis* and *B. speciosa* did not form a homogeneous group with the remainder of the species placed in *Boriomyia,* erected a new subgenus, *Allotomyia,* for these two species and subsequently (1935) treated this group as a full genus.

Killington (1937) agreed that the two groups of species recognized by Banks should be separated generically, but pointed out that since the name *Boriomyia* had been validated in 1904 when it was used in combination with two already-described species, Banks' 1905 designation of *H. disjunctus* as the type of *Boriomyia* was in violation of the Rules since this species was not included in *Boriomyia* when this name was originally validated. Designating *H. fidelis* as the type species of *Boriomyia,* Killington proposed the name *Kimminsia* for the British species formerly included in *Boriomyia,* the remaining non-British species of the former *Boriomyia* (other than *B. speciosa*) presumably being also referable to this genus. A Palaearctic species, *H. betulina* Strøm was selected as the type of *Kimminsia.* These two genera were considered to be separated by venational features which had already been noted by Banks. These views were reiterated by Killington in 1937b. Tjeder (1941) in a critique of Killington's work and without specimens of *B. fidelis* to study felt that the venational distinctions which had been drawn between *Boriomyia* and *Kimminsia* were not sufficient to warrant generic separation. Subsequently in a long series of papers (1943a, 1943b, 1944, 1945, 1951, 1953a, 1953b, 1954, 1955, 1960), he has continued to use the name *Boriomyia* to cover the *Kimminsia* group of species.

Circumstances have thus conspired to make it seem that *Kimminsia* is a taxonomic segregate from the closely allied genus *Boriomyia* and that the question of whether to recognize one genus or two simply depends on the emphasis which one places on the differences in the venation of these two groups. Actually this is misleading, for as long ago as 1940 Carpenter pointed out that the differences between these two genera are much more far-reaching than had been suspected, involving not only consistent differences in venation, but fundamental differences in the basic organization of the genitalia of both sexes. Indeed, it was Carpenter's contention that the true affinities of *Boriomyia* lie not with *Kimminsia* at all, but rather with the genus *Megalomus*.

The findings of the present study lend complete support to this view. Details of the biology of the Palaearctic *Megalomus hirtus* (Linné) including several excellent figures of the larvae have been published by Killington (1934, 1937a), while the present author has reared the immature stages of an unidentified species of *Megalomus* from Mexico. In addition, modern figures and descriptions of larvae of species of *Kimminsia, Wesmaelius, Psectra, Sympherobius, Hemerobius, Micromus,* and *Drepanepteryx* have also been provided by Smith (1923, 1934), Killington (1936, 1937a, 1946) and Fulmek (1941) and as the writer has been able to rear or study larvae of species of the last four of these genera, detailed comparisons of a variety of larval types of the Hemerobiidae have been possible.

Only in very general features shared by the larvae of all known hemerobiids do those larvae of *Micromus, Hemerobius, Wesmaelius* and *Kimminsia* which are known bear any close structural resemblance to the larvae of the remaining groups and they will not be discussed further. A series of striking similarities is to be found in the larvae of *Boriomyia* and *Megalomus* involving the shape of the labial palpi, the form of the terminal segment of the antenna and in the appearance of the mature larva. The swollen, inflated shape of the labial palpi, particularly striking in the first instar larvae, but noticeable in the later two instars as well, is present only in *Sympherobius* and *Psectra* in addition to *Megalomus* and *Boriomyia* although it has never been observed to reach the extreme degree in the first two of these genera that it does in the latter two. The extremely shortened terminal segment of the antenna, surmounted by an apical seta nearly as long as or longer than this segment, is known to the writer only in *Boriomyia* and *Megalomus*. A much less drastic reduction in the terminal segment occurs in *Sympherobius*, but here the segment is somewhat flaskshaped as it is dilated basally and the terminal seta is much shorter than the length of the segment. The swollen, physogastric appearance of the mature larva has probably been produced several times independently in the Hemerobiidae in correlation with a more sessile mode of larval life. The condition has been approached in *Sympherobius, Psectra* and *Drepanepteryx* although in no species of these groups known to the writer does it reach the extreme which has been produced in *Boriomyia* and *Megalomus*. Associated with this inflated, sessile larva is the habit of carrying the head deeply retracted within the prothorax, developed to an extreme degree in *Boriomyia, Megalomus,* and *Drepaneptaryx,* and the supression of the latero-dorsal sclerites of the thoracic segments. In *Sympherobius, Psectra* and *Drepanepteryx* these sclerites have been strongly reduced on the meso- and metathorax, but those of the prothorax have remained relatively large and prominent. In *Boriomyia* and *Megalomus* alone have the prothoracic latero-dorsal sclerites been reduced to the point where they are difficult to demonstrate. Killington states that these sclerites are lacking on the prothorax of *M. hirtus* although it seems possible that close scrutiny might reveal their presence since their remnants can just be detected in *B. fidelis* as well as the Mexican species of *Megalomus* studied by the writer. One additional point of resemblance between members of *Boriomyia* and *Megalomus* is to be found in the peculiar rest position of the adult noted above for *B. fidelis,* which was observed by the writer in adults of the Mexican species of *Megalomus* studied, and noted by Killington (1937a) in *M. hirtus.*

The writer has presented the evidence for the relationship of *Boriomyia* and *Megalomus* to Mr. Tjeder who, it has been noted, previously felt that there were insufficient characters to separate *Kimminsia* from *Boriomyia.* In addition, specimens of *B. fidelis* were supplied for his study. Mr. Tjeder has informed the writer *(in litt.)* that he is now in full agreement with the placement of *B. fidelis* near *Megalomus* (indeed, he feels that this species must be placed in *Megalomus*). He has, however, continued to use the name *Boriomyia* for the *Kimminsia* species (Tjeder, 1960), arguing *(in litt.)* that Banks' genotype designation for *Boriomyia* in 1905 must be considered valid. The writer is of the opinion that the Rules are perfectly clear on this point and that the validation of Banks' designation would require an action of the International Commission to set aside the Rules. It should be noted that in addition to Killington (1937a, 1937b) and Carpenter (1940), Fraser (1940, 1942, 1959), Friedrich (1953), Nakahara (1956, 1960) and Parfin (1956) have used the names *Boriomyia* and *Kimminsia* in the sense adopted in the present paper.

Concerning the question of the validity of *Boriomyia* as a genus distinct from *Megalomus,* this must await a study of the type species of *Megalomus,* the Palaearctic *M. tortricoides Rambur,* as well as a wider variety of species of this genus than has been available to the present writer. Carpenter (1940) was able to separate these genera on the basis of the position of the radial cross vein with reference to the point of origin of R5 in the hindwing, although he felt that species which were intermediate in this character would probably be found. Recently Nakahara (1960) has observed that *B. fidelis* possesses a median lobe of the fused parameres of the male genitalia (present also in *B. speciosa*) which is said to be lacking in species of *Megalomus.* A second character of *B. fidelis* considered by Nakahara to be of generic importance, the basally fused and apically bifucrate "aedeagus", is present also in at least the Nearctic species *M. minor* Banks which is a *Megalomus* by the criterion of a lack of the median lobe of the fused parameres.

It is the opinion of the present writer that stable generic limits in the Hemerobiidae usually involve greater differences in the basic ground plan of the male genitalia than those aduced by Nakahara, and frequently correlate with differences in the structure of one or more of the immature stages and in constant venational features as well. In these respects, *Boriomyia* seems poorly distinct from *Megalomus* and will probably fall as a synonym of this genus.

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THE FEMALE OF *INOCELLIA PILICORNIS* CARP. (NEUROPTERA: INOCELLIIDAE).[1]

By F. M. Carpenter
Harvard University

The snakefly, *Inocellia pilicornis* Carpenter, was described in 1959 (Psyche, *65*:56-58) from three males collected in the states of Nuevo Leon and Tamaulipas, Mexico. These males were unique among known Raphidiodea in possessing moniliform antennae, their segments bearing long radiating setae, arranged in a definite pattern. In July, 1960, Dr. H. F. Howden, who collected one of the males of the original set, found the first known female of this species, along with another male, very near the type locality. It now turns out that the female also has moniliform antennae, but the hair covering of the antennae, although distinctly different from that of other species, is not as similar to that of the male of *pilicornis* as might be expected.

The color markings of the female are like those of the male type, except that the median white marks on the meso- and metanotum and the abdominal tergites are in the form of patches instead of a continuous stripe. The forewing is 6.8 mm. long and 1.8 mm. wide; the pterostigma, having a maximum length of 1 mm. and a width of a little less than .5 mm., is relatively shorter than in the male. The wing venation is like that of the holotype, illustrated in my account

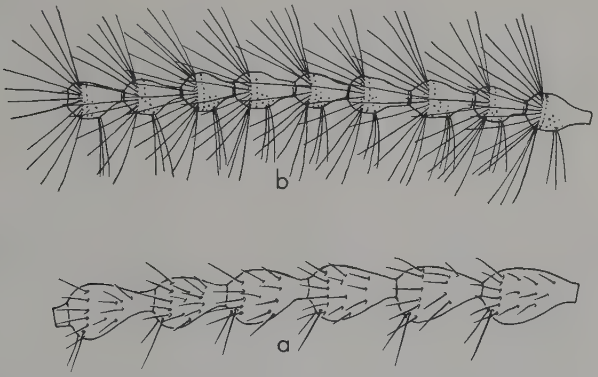

Figure 1. Portions of antennae of *Inocellia pilicornis* Carp. a, female, x 140 (specimen from Chipinguy Mesa); b, male, x 55 (holotype).

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[1] Published with the aid of a grant from the Museum of Comparative Zoology at Harvard College.

of the species. The antennae of the female are 3.7 mm. long. Each consists of 42 segments, instead of 60 as in the male, and the individual segments are smaller than in the male. The hairs on the antennal segments are shorter than those of the male and form a different pattern (figure 1). A ring of twelve conspicuous setae is located near the distal end of each segment and two prominent hairs occur on one side of each segment, slightly distal of the ring just mentioned; these two hairs are a little longer than the hairs comprising the ring and they almost always project in the same direction, as shown in figure 1a. The more proximal part of each antennal segment includes about 20 short hairs which are arranged somewhat irregularly and which do not form a second ring, as in the male. The ovipositor of the female is like that of other *Inocellia;* in the specimen at hand it is 5.5 mm. long. The body length of the female, exclusive of the antennae and ovipositor, is 6 mm.

It seems virtually certain that this new female, which was collected at Chipinguy Mesa, near Monterrey, Nuevo Leon, Mexico, July 28, 1960, belongs to *pilicornis*. A male, collected by Dr. Howden at the same time, is like the holotype, except that the white markings on the abdominal tergites are somewhat smaller.

Although the female turns out to have antennal characteristics as distinctive as those of the male, I do not believe that a new genus is necessary for this species. Other features, including the abdominal structures of the male and female, are similar to those of other species of *Inocellia*.

A NOTE ON THE PREY AND A NESTING SITE OF *CERCERIS TRUNCATA* CAMERON (HYMENOPTERA: SPHECIDAE: PHILANTHINAE)

By F. G. Werner

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This species seems to be very rare or extremely local in southern Arizona; Dr. H. A. Scullen, who has kindly provided the identification, held it as undescribed until he discovered that it had been described from Mexico by Cameron. However, there is a rather extensive nesting site in my own yard, at 1247 N. Warren Ave., Tucson. During the past four years I have been able to observe the habits of the species regularly and have found that the females store only beetles of the family Bruchidae (Mylabridae). The species stored at this site are all of medium size, and probably all come from leguminous trees and shrubs in the neighborhood. In order of abundance the bruchids gathered are: *Algarobius prosopis* (Lec.), *Mimosestes protractus* (Horn), *Mimosestes amicus* (Horn) and *Neltumius arizonensis* (Schffr.); this is roughly the relative abundance of these species when they are taken in general collecting. The most abundant source tree in the neighborhood is the so-called Mexican palo verde, *Parkinsonia,* which is planted extensively, blooms in the spring and has mature pods by mid-July, when the wasps become active.

The site occupied is on flat ground in the southwestern corner of the lot, about 10′ x 10′, shielded on south and west by a five-foot wall and partly shaded by large oleander bushes; the soil is bare and consists of well-packed fill about eight inches deep over caliche; almost all of the water that reaches it comes from rainfall. Activity of the wasps was checked weekly in 1958, when the first swarms of males and starts of nests were observed on July 20 and could not have started more than a week before this date. The males fly continually during the day, just over the oleander bushes and nearby vegetation, stopping occasionally to rest. Hundreds of individuals are involved in these flights. Smaller numbers, usually about twenty, patrol the nesting site, flying about four inches above the ground, and attempt copulation with females flying in the area or returning to their nests with prey. I could not discover where the males went at night. The females dig small holes, either bare or with a low mound up to 1½″ in diameter. Most of their flying and provisioning activity occurs in the morning but even then the principal activity seems to consist of sitting in the nest entrance with only the front of the head exposed. By noon all is quiet and most of the nest entrances are loosely plugged, only the occasional pushing up of dirt in some of the nests indicating that digging may be in progress. Marked nests were open for two or three days, except when they were plugged with loose dirt in the afternoon, and one nest was open at least five days. The nests were hard to keep track of during the period of observation because of frequent rains. By July 27 there were 55 nests in a marked area 4′ x 4′ and there were at least this many active during the rest of the summer. *Solenopsis* ants raided part of the site but there was no sign of social or other parasites.

Individual nests were dug up but none could be excavated completely. The holes could be followed down to about 4″, where they seemed to end in loose dirt; below some of them, at 5″ to 6″, a cluster of up to ten bruchids, with an egg or larva, indicated where the cell must have been. The cells must be of very loose construction. Nesting activity and male swarming continued from mid-July well into September in 1958, gradually diminishing during the latter month. A similar schedule has been maintained in the two succeeding years. No adults have been seen until July, the normal starting time of the summer monsoon season.

THE TYPE SPECIES OF THE ANT GENUS *EURHOPALOTHRIX*. — In our paper, "A world revision of the ant tribe Basicerotini," Studia Entomologica, Petrópolis, Brazil, *3:* 202, 1960, we erected a new genus *Eurhopalothrix* to receive certain species formerly placed in *Rhopalothrix* Mayr, along with some new species. Through inadvertance, no type species was cited for the new genus, and we therefore here designate *Eurhopalothrix bolaui* (=*Rhopalothrix bolaui* Mayr, 1870) as type species of the genus *Eurhopalothrix* Brown and Kempf. — W. L. Brown, Jr., Department of Entomology, Cornell University, Ithaca, N. Y., and W. W. Kempf, O. F. M., São Paulo, Brazil.

CAMBRIDGE ENTOMOLOGICAL CLUB

A regular meeting of the Club is held on the second Tuesday of each month October through May at 8:00 p. m. in Room B-455, Biological Laboratories, Divinity Ave., Cambridge. Entomologists visiting the vicinity are cordially invited to attend.

The illustration on the front cover of this issue of Psyche shows the head of the worker of *Myrmoteras karnyi* Gregg. The original, drawn by Dr. R. E. Gregg, was published in Psyche, Volume 61, p. 21, 1954.

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